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Species Composition of Leaf Beetle Assemblages in Deciduous Tree Canopies in Hungary (Coleoptera: Chrysomelidae)[1]

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Abstract. The species richness and species composition of Coleoptera assemblages were investigated in deciduous tree canopies in Hungary. Apple and pear orchards were investigated in Nagykovácsi, Kecskemét and Sárospatak in 1990–94, and limes and maples in Keszthely in 1999–2002. This study presents in detail the findings on leaf beetles.

Earlier investigations in Hungary revealed surprisingly high diversity of Coleoptera assemblages in the canopy of apple and pear orchards. Altogether 324 species, almost 3 per cent of Hungary's beetle fauna, were represented: 253 in apple and 188 in pear orchards. The majority of the species belonged to the Curculionidae, Chrysomelidae and Coccinelidae families. The proportion of leaf beetles ranged between 15 and 20 %. The commonest leaf-beetle species in the canopy of the commercial orchards investigated were *Phyllotreta vittula*, *Phyllotreta atra*, *Phyllotreta nigripes*, *Oulema melanopus*, and *Aphthona euphorbiae*. In the abandoned orchards, the commonest were *Luperus xanthopoda*, *Smaragdina salicina* and *Orsodacne lineola*.

Examination of the fauna of parks, avenues and other planted urban plant stocks has only begun to occupy researchers in the last decade. Analysis of the full Arthropoda assemblages of these plant stocks has still not been undertaken. The proportion of leaf-beetle species in the material gathered on maples and limes in Keszthely ranged between 17.0 and 21.3 per cent. Apart form leaf beetles, the bulk of the specimen material collected consisted of species of the Coccinellidae, Staphylinidae and Curculionidae families. The commonest leaf-beetle specimens collected in the lime canopy were *Aphthona euphorbiae, Chaetocnema tibialis, Longitarsus lycopi, Longitarsus pellucidus, Longitarsus pratensis* and *Longitarsus succineus*. The commonest on maple were *Aphthona euphorbiae, Chaetocnema concinna, Chaetocnema tibialis, Longitarsus lycopi, Longitarsus pellucidus, Longitarsus succineus, Phyllotreta cruciferae* and *Phyllotreta vittula*.

It was concluded that leaf beetles contribute a high proportion of the biodiversity of the deciduous tree canopy, sometimes occurring with high species richness and abundance. However, the reasons for this occurrence and their potential role are poorly understood.

Key words. Coleoptera, Chrysomelidae, Hungary, faunistics, deciduous tree canopy fauna

1. INTRODUCTION

Attention focused on apple and pear orchards during the development of integrated plant-protection methods. Knowledge of the biology of some key pests and predators (BALÁZS 1992; BLOMMERS 1994; HERARD 1986) is extensive enough to describe the role of these organisms in the ecological processes of such orchards. Yet the species composition and diversity of the total arthropod assemblages are still poorly known, although the information could be essential to a general understanding of the biodiversity relations of the plantations.

Two long-term investigations of the arthropod fauna of apple orchards in Hungary have been carried out in the last century (ZILAHI-SEBESS 1955; MÉSZÁROS 1984). An additional investigation focused on the Coleoptera assemblages of apple and pear orchards in Hungary (MARKÓ et al. 1995).

Examination of the fauna of parks, avenues and other planted urban plant stocks has only begun to occupy researchers in the last decade. This research had several objectives, but plant-protection criteria were dominant. Nonetheless, analysis of the full Arthropoda assemblages of these plant stocks has still not been undertaken.

This study aims to compare the leaf-beetle samples collected in the canopy of deciduous trees in Hungary and explain the similarities and differences between the samples.

2. MATERIALS AND METHODS

Investigations of the canopy fauna of apple and pear orchards were carried out in three geographical regions of Hungary. The samples were collected at the following localities. Nagykovácsi (3 plots) is situated in the centre of Hungary in woodland amidst hills of medium height and surrounded by mixed oak forest. Kecskemét (5 plots), situated in the Great Hungarian Plain, and Sáro-

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spatak (4 plots) in Northern Hungary both lie in a lowland agricultural environment. Some of the selected plots had been untreated, and others treated with broad-spectrum insecticides (mainly organophosphorus insecticides and pyrethroids), and also treated with selective insecticides (mainly IGR pesticides) in IPM orchards. The samples restricted to the canopies were collected between 1990 and 1994, from April to November, by beating methods, using the Winkler-type umbrella (Ø 0.7 m) or 0.25 m^2 plastic sheet. Sampling per year varied between 12 and 22 occasions. The number of trees per sampling varied between 10 to 30. Table 1 shows the parameters of each area investigated.

Table 1. Description of the orchards investigated in Hungary (after MARKÓ et al. 1995)

	Woodland in hill of medium height			**Agricultural lowland**			
	Nagykovácsi			Kecskemét			Sárospatak
Fruit species	apple	pear	pear	apple	apple	apple	pear
Age of plantation	M	M	M	Y	Y	M	M
Size of plantation	5.8 ha	1.1 ha	51 ha	2 ha	2 ha	5–6 ha	50.6 ha
Untreated	+	+					
Conventionally treated			+	+	+	+	+
IPM applied				+	+	+	+
No. of treatments	–	–	3–6	7–8	7–8	7–8	7–8
Collecting method	U	U	U	U	S	U	U
Years	1990–92	1992–4	1992–4	1992–3	1992–4	1992–4	1993–4
Sampling per year	12	12	12	12	23–24	21–22	4/1993 7/1994
Trees per sampling	10	10	12	10	30 branches	10	10

M = mature tree, more than 13 years old; Y = younger than 13 years old; U = umbrella; S = plastic sheet

Investigation of lime and maple canopies was carried out in Keszthely and vicinity in 1999–2002. Keszthely lies in the middle of Western Hungary at the western end of Lake Balaton, in a basically agricultural lowland environment. Collections were made 8–10 times during the vegetation period, using pyrethroid spraying of the whole canopy and canopy netting (Ø = 0.5 m). The number of trees per sampling varied between 4 to 10.

The composition of the chrysomelid communities was compared by metric ordination (principal coordinate analysis—PCoA), based on the Horn index, after log2 transformation of the data, and the Jaccard similarity index (KREBS 1989), using the Syntax 5.1 program (PODANI 1997). The starting data for these analyses were obtained by aggregating all the individuals collected in the canopy of the orchard investigated (apple and pear) or tree species (lime and maple).

3. RESULTS

Tables 2, 3, 4 and 5 show the results obtained in the canopies of the apple and pear orchards. There were a total of 253 Coleoptera species in the canopies of apple trees and 188 Coleoptera species in those of pear trees (MARKÓ et al. 1995). At Nagykovácsi, altogether 14,917 specimens of Coleoptera were collected, of which 756 specimens were leaf beetles; there were 176 Coleoptera species collected, of which 36 were leaf-beetle species (Table 2). The number of leaf-beetle specimens collected in Nagykovácsi in 1990–94 appears in Table 3. The commonest leaf-beetle species in the canopy of conventionally treated pear orchard were *Luperus xanthopoda* (Schrank, 1781), *Phyllotreta atra* (Fabricius, 1775), *Phyllotreta nigripes* (Fabricius, 1775) and *Phyllotreta vittula* (Redtenbacher, 1849). In the abandoned apple orchards, the commonest was *L. xanthopoda*, while in the untreated pear orchard, the commonest were *L. xanthopoda*, *Smaragdina (Monrosia) salicina* (Scopoli, 1763) and *Orsodacne lineola* (Panzer, 1794). The high proportion of *L. xanthopoda* in all orchards was probably due to the large number of wild cherry trees in the surrounding mixed oak forest. It is interesting that the number of *P. vittula* was high in the conventionally treated pear orchards in the years investigated. This leaf beetle is not a pear-feeding phytophagous species, its diet being restricted to cruciferous plants and grasses (VIG 1998). The reason of its occurrence in the pear canopy is unknown.

Table 2. Number of Coleoptera specimens and species collected in apple and pear-orchard canopies in Nagykovácsi, Hungary (1990–94)

	A	B	C	Total
Total Coleoptera specimens	7,430	4,506	2,981	14,917
Total Coleoptera species	125	95	70	176
No. of Chrysomelidae specimens	168	181	407	756
No. of Chrysomelidae species	24	17	19	36

A = untreated pear (1990–92); B = untreated apple (1990–92); C = conventionally treated pear (1992–4)

Table 3. Number of leaf-beetle specimens collected in apple and pear-orchards in Nagykovácsi, Hungary (1990–94)

Species	A	B	C	Species	A	B	C
Altica sp.	–	17	3	*Luperus xanthopoda* (Schrank, 1781)	52	133	57
Altica oleracea (Linnaeus, 1758)	–	–	1	*Orsodacne lineola* (Panzer, 1794)	31	–	1
Aphthona euphorbiae (Schrank, 1781)	3	2	6	*Oulema melanopus* (Linnaeus, 1758)	2	3	5
Cassida (s. str.) *flaveola* Thunberg, 1794	1	–	–	*Pachybrachis tessellatus* (Olivier, 1791)	1	1	–
Cassida *(s. str.)* nebulosa *Linnaeus, 1758*	7	1	1	*Phyllotreta atra* (Fabricius, 1775)	–	1	32
Chaetocnema (Tlanoma) concinna (Marsham, 1802)	–	–	6	*Phyllotreta cruciferae* (Goeze, 1777)	1	1	7
Chaetocnema (Tlanoma) tibialis (Illiger, 1807)	2	–	–	*Phyllotreta diademata* Foudras, 1859	–	–	1
Clytra laeviuscula (Ratzeburg, 1837)	3	–	–	*Phyllotreta nemorum* (Linnaeus, 1758)	2	3	3
Crepidodera aurata (Marsham, 1802)	–	–	1	*Phyllotreta nigripes* (Fabricius, 1775)	3	3	34
Cryptocephalus (s. str.) *hypochaeridis* (Linnaeus, 1758)	1	2	–	*Phyllotreta nodicornis* (Marsham, 1802)	1	–	–
Cryptocephalus (Burlinius) chrysopus Gmelin, 1790	1	3	–	*Phyllotreta undulata* Kutschera, 1860	–	–	1
Cryptocephalus (s. str.) *imperialis* Laicharting, 1781	3	–	–	*Phyllotreta vittula* (Redtenbacher, 1849)	4	–	245
Cryptocephalus (s. str.) *nitidus* (Linnaeus, 1758)	5	–	–	*Psylliodes* (s. str.) *tricolor* Weise, 1888	–	–	1
Cryptocephalus (s. str.) *nitidus* (Linnaeus, 1758)	–	3	–	*Smaragdina (Monrosia) affinis* (Illiger, 1794)	–	1	–
Gastrophysa polygoni (Linnaeus, 1758)	1	–	–	*Smaragdina (Monrosia) aurita* (Linnaeus, 1767)	1	–	–
Labidostomis longimana (Linnaeus, 1761)	1	–	–	*Smaragdina (Monrosia) salicina* (Scopoli, 1763)	31	3	1
Lachnaia sexpunctata (Scopoli, 1763)	6	3	–	*Sphaeroderma testaceum* (Fabricius, 1775)	–	–	1

A = untreated pear (1990–92); B = untreated apple (1990–92); C = conventionally treated pear (1992–4)

Table 4. Number of Coleoptera specimens and species collected in apple-orchard canopies in Kecskemét, Hungary (1992–94)

	A	B	C	D	E	Total
Total Coleoptera specimens	2075	507	474	449	505	4010
Total Coleoptera species	85	54	45	39	46	131
No. of Chrysomelidae specimens	36	24	13	18	16	107
No. of Chrysomelidae species	14	8	5	7	5	19

A = mature, IPM applied; B = mature, conventionally treated with board-spectrum insecticides; C = young, conventionally treated; D = young, IPM applied; E = young, IPM applied

Table 5. Number of Coleoptera specimens and species collected in pear-orchard canopies in Sárospatak, Hungary (1993–4)

	A	B	Total
Total Coleoptera specimens	490	427	917
Total Coleoptera species	31	31	45
No. of Chrysomelidae specimens	8	19	27
No. of Chrysomelidae species	2	5	6

A = conventionally treated; B = untreated and IPM applied

Table 6. Number of Coleoptera specimens and species and number and proportion of leaf-beetle specimens and species collected in lime and maple canopies in Keszthely, Hungary (1999–2002)

	A	B	Total
Total Coleoptera specimens	4054	2404	6458
Total Coleoptera species	182	211	283
No. (proportion) of Chrysomelidae specimens	266 (6.6%)	441 (18.3%)	707 (10.94%)
No. (proportion) of Chrysomelidae species	31 (17.0%)	45 (21.3%)	53 (18.73)

A = lime; B = maple

At Kecskemét, altogether 4010 Coleoptera specimens were collected of which 107 specimens were leaf beetles and there were 131 Coleoptera species collected of which 19 leaf beetle species were captured (Table 4.). Interestingly, *P. vittula* dominated in both the conventionally and selectively insecticide-treated apple orchards at the end of June and in mid-July in the years investigated.

At Sárospatak, altogether 917 Coleoptera specimens were collected, of which 27 specimens were leaf beetles. There were 45 Coleoptera species represented, including six leaf-beetle species (Table 5).

Table 6 summarizes the results obtained during the investigation of the canopies of lime and maple trees in Hungary. There were a total of 182 Coleoptera species in the lime canopies and 211 Coleoptera species in the maple. At Keszthely, altogether 6458 Coleoptera specimens were collected, of which 707 specimens were leaf beetles. Of the 283 Coleoptera species collected, 53 were leaf-beetle species. The commonest leaf beetle species in the lime canopy were *Aphthona euphorbiae* (Schrank, 1781), *Chaetocnema (Tlanoma) tibialis* (Illiger, 1807), *Longitarsus* (s. str.) *lycopi* (Foudras, 1860), *Longitarsus* (s. str.) *pellucidus* (Foudras, 1860), *Longitarsus* (s. str.) *pratensis* (Panzer, 1794) and *Longitarsus* (s. str.) *succineus* (Foudras, 1860), and in the maple canopy *A. euphorbiae*, *Chaetocnema (Tlanoma) concinna* (Marsham, 1802), *C. tibialis*, *L. lycopi*, *L. pellucidus*, *L. succineus*, *Phyllotreta cruciferae* (Goeze, 1777) and *P. vittula* (Table 7).

The results of metric ordinations show clear differences between the treatments and tree families. The composition (species composition and relative abundance) of leaf-beetle assemblages in the canopies of untreated apple and pear trees was very similar and distinct from the

Table 7. Number of leaf-beetle specimens collected in lime and maple canopies in Keszthely, Hungary (1999–2002)

Species	A	B	Species	A	B
Altica oleracea (Linnaeus, 1758)	–	7	*Longitarsus* (s. str.) *lewisii* (Baly, 1874)	1	2
Aphthona abdominalis (Duftschmid, 1825)	–	2	*Longitarsus* (s. str.) *luridus* (Scopoli, 1763)	7	10
Aphthona euphorbiae (Schrank, 1781)	12	15	*Longitarsus* (s. str.) *lycopi* (Foudras, 1860)	19	24
Aphtona nonstriata (Goeze, 1777)	–	1	*Longitarsus* (s. str.) *melanocephalus* (De Geer, 1775)	–	1
Aphthona semicyanea Allard, 1859	–	1	*Longitarsus* (s. str.) *nasturtii* (Fabricius, 1792)	8	7
Aphthona venustula (Kutschera, 1861)	2	2	*Longitarsus* (s. str.) *pellucidus* (Foudras, 1860)	29	38
Cassida (Mionychella) hemisphaerica Herbst, 1799	–	3	*Longitarsus* (s. str.) *pratensis* (Panzer, 1794)	10	11
Cassida (Hypocassida) subferruginea Schrank, 1776	1	1	*Longitarsus* (s. str.) *rubiginosus* (Foudras, 1860)	–	5
Chaetocnema (s. str.) *aridula* (Gyllenhal, 1827)	–	1	*Longitarsus* (s. str.) *substriatus* Kutschera, 1863	1	3
Chaetocnema (Tlanoma) concinna (Marsham, 1802)	7	14	*Longitarsus* (s. str.) *succineus* (Foudras, 1860)	35	34
Chaetocnema (s. str.) *hortensis* (Geoffroy, 1785)	–	7	*Neocrepidodera ferruginea* (Scopoli, 1763)	2	6
Chaetocnema (Tlanoma) picipes Stephens, 1831	5	10	*Phyllotreta astrachanica* Lopatin, 1977	1	6
Chaetocnema (Tlanoma) tibialis (Illiger, 1807)	17	77	*Phyllotreta cruciferae* (Goeze, 1777)	9	17
Chrysolina (Menthastriella) herbacea (Duftschmid, 1825)	–	1	*Phyllotreta diademata* Foudras, 1859	–	6
Clytra laeviuscula (Ratzeburg, 1837)	–	2	*Phyllotreta nemorum* (Linnaeus, 1758)	–	1
Crepidodera aurata (Marsham, 1802)	2	3	*Phyllotreta nigripes* (Fabricius, 1775)	3	10
Cryptocephalus (Burlinius) planifrons Weise, 1882	1	–	*Phyllotreta procera* (Redtenbacher, 1849)	3	7
Cryptocephalus (s. str.) *sericeus* (Linnaeus, 1758)	1	–	*Phyllotreta striolata* (Fabricius, 1803)	–	1
Epitrix pubescens (Koch, 1803)	2	3	*Phyllotreta undulata* Kutschera, 1860	1	5
Galeruca (s. str.) *pomonae* (Scopoli, 1763)	–	1	*Phyllotreta vittula* (Redtenbacher, 1849)	5	22
Longitarsus sp. 1	–	1	*Psylliodes* (s. str.) *chrysocephalus* (Linnaeus, 1758)	2	7
Longitarsus sp. 2	1	–	*Psylliodes* (s. str.) *illyricus* Leonardi & Gruev, 1993	–	1
Longitarsus (s. str.) *kutscherae* (Rye, 1872)	2	1	*Psylliodes* (s. str.) *napi* (Fabricius, 1792)	1	1
Longitarsus (s. str.) *lateripunctatus personatus* Weise, 1893	2	1	*Psylliodes* (s. str.) *picinus* (Marsham, 1802)	–	1

A = lime (1999–2001; B = maple (1999–2002)

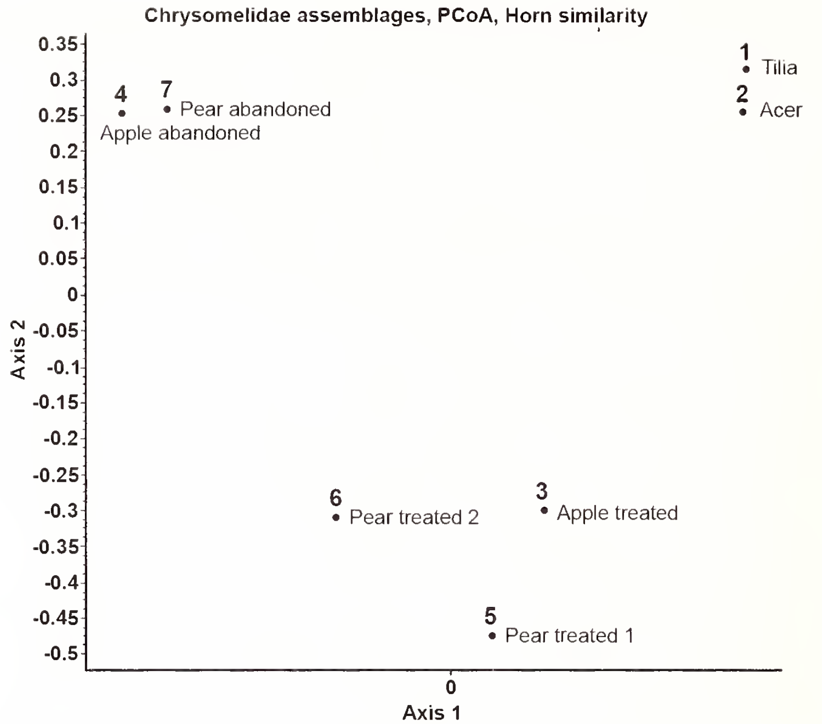

Fig. 1. Examination of the similarity of leaf-beetle assemblages gathered on various deciduous trees, by metric ordination (Horn index).

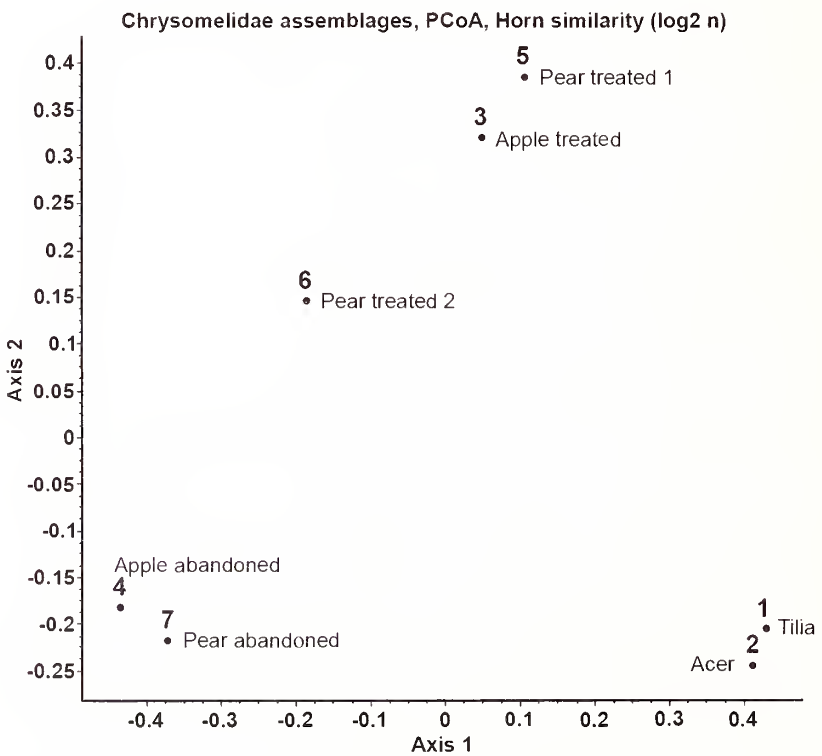

Fig. 2. Examination of the similarity of leaf-beetle assemblages gathered on various deciduous trees, by metric ordination (Horn index, after log2 (x+1) transformation of the raw data).

assemblages of maple and lime trees (Fig. 1). However, the abandoned orchards were situated in the same district (Nagykovácsi) and the maple and lime trees in a different one (Keszthely). It can also be seen that characteristic chrysomelid assemblages were formed in commercial orchards, regardless of differences in their surroundings. On the other hand, the commercial pear orchard2 (No. 6 in the figures) is clearly distinct from the abandoned orchards, despite all being situated in the same district (Fig. 1). The results are similar if the analysis based on log2 transformed data are compared, or only the species compositions (Jaccard index). In these analysis, the role of the commonest, dominant species was lower (log2 transformation) or relative abundance was not taken into consideration (Jaccard similarity) in the comparisons (Figs. 2 and 3). So the results show the basic structure of the chrysomelid assemblages. The neighbouring habitats seem to be more important in forming the species composition of the chrysomelid assemblages. The species composition in the commercial pear orchard2 was closer to the abandoned ones from the same location than to the other commercial orchards. Similarly, the leaf beetle assemblages in the canopies of lime and maple trees from the same location, Keszthely show remarkably similar composition (Fig. 3).

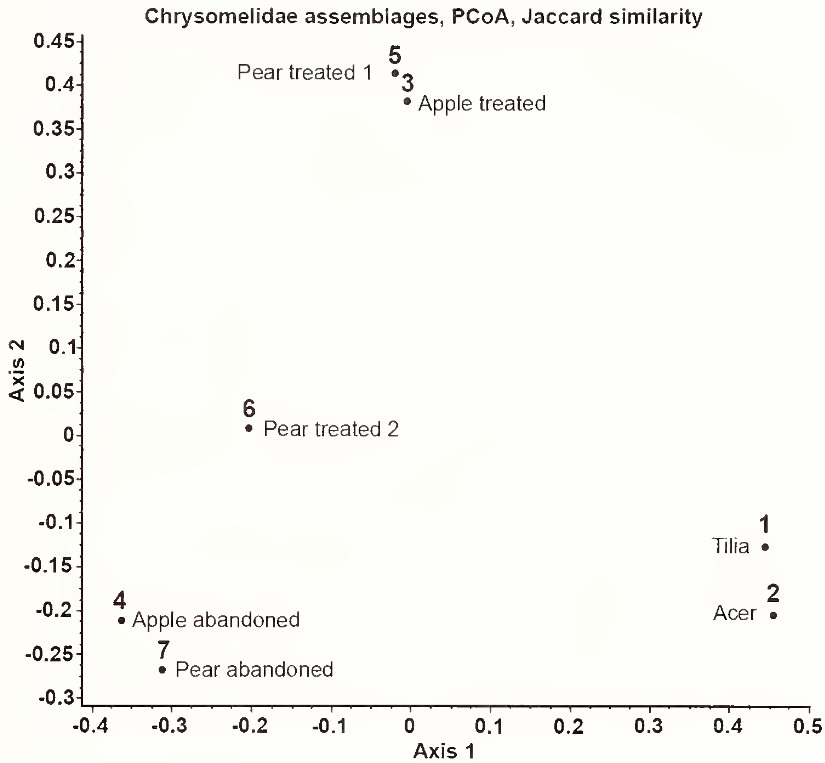

Fig. 3. Examination of the similarity of leaf-beetle assemblages gathered on various deciduous trees, by metric ordination (Jaccard index).

4. DISCUSSION

The leaf-beetle assemblages examined consist of species that sometimes feed on the tree species concerned and much larger specimen and species numbers of visiting species. The untreated apple and pear orchards typically had large numbers of specimens of species feeding on the trees *(L. xanthopoda* and *O. lineola)*. Treatment obviously increases the proportion in the assemblages of visiting species less tied to a food plant (principally and sometimes exclusively *Phyllotreta vittula*), and this causes the distinction in the commercial plantations. On lime and maple species, however, visiting species were found almost exclusively, so that the different characteristics of the two species of tree do not give them distinct beetle faunas. The tourists have a decisive role in species composition. The relatively large number of tourist species (*A. euphorbiae*, *Cassida* (s. str.) *nebulosa* Linnaeus, 1758, *C. concinna*, *Cryptocephalus* (s. str.) *nitidus* (Linnaeus, 1758), *Lachnaia sexpunctata* (Scopoli, 1763), *Oulema melanopus* (Linnaeus, 1758), *P. atra*, *P. cruciferae*, *Phyllotreta nemorum* (Linnaeus, 1758), *P. nigripes*, *P. vittula* and *S. (M.) salicina* in Nagykovácsi and 283 species in the case of Keszthely) have arrived from the environs, so that the species composition is more similar on trees found in the same environment. The explanation for this, as said

earlier, is that the environs of the trees have the decisive effect on the development of the species composition.

Leaf beetles contribute a high proportion of the biodiversity of the deciduous tree canopy, sometimes occurring with high species richness and abundance. However, the reasons for this occurrence and their potential role are poorly understood. Most of the species are certainly tourists, which arrived in the canopy by chance, since these tree species are not their food plant. However, it cannot be ruled out that some species may occasionally draw moisture from the leaves of the deciduous tree species examined, especially if the main food plant has become inedible. With some species, consumption of honeydew or sooty moulds is conceivable, although unsupported by observations specific to these species.

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